

United States Patent [19]

Banyasz et al.

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[54] METHOD AND APPARATUS FOR
DETECTING A MISSING OBJECT IN A SET
OF OBJECTS

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[56] References Cited

U.S. PATENT DOCUMENTS

3,339,195 8/1967 Murley 340/674
4,166,973 9/1979 Lilly 324/58.5 B
4,358,731 11/1982 Steinbrecher 324/58.5 R
4,381,485 4/1983 Steinbrecher 324/58 C
4,603,329 7/1986 Bangerter 340/674
4,620,146 10/1986 Ishikawa 324/58.5 A
4,716,360 12/1987 Pakulis 324/58.5 A

4,789,820 12/1988 Parrent 324/58.5 R

FOREIGN PATENT DOCUMENTS

3612749 10/1987 Fedi Rep. of Germany 324/58.5
A

OTHER PUBLICATIONS

P. F. Goldsmith, "Quasi-Optical Techniques at Milli-
meter and Submillimeter Wavelengths," *Infrared and
Millimeter Waves*, vol. 6, ch. 5, (K. J. Button, ed., 1982).
P. F. Goldsmith et al., "Gaussian Optics Lens Anten-
nas," *Microwave Journal*, Jul. 1984, (Millitech Corpora-
tion reprint, Sep. 1984).

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[57] ABSTRACT

A millimeter wave detector for detecting missing ciga-
rette packs or other types of objects in a set of objects is
provided. The detector uses millimeter wave radiation
at about 90 GHz to resolve small features of the objects
being scanned. The detector can detect defects or miss-
ing packs in configurations that would not be detected
by previously known detectors.

20 Claims, 9 Drawing Sheets

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